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The effect of auditory enrichment, rearing method and social environment on the behavior of zoo-housed psittacines (Aves: Psittaformes); implications for welfare

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Abstract

The psychological and physiological effects of different genres of music are well documented in humans. These concepts have also been studied in kenneled dogs and some exotic animals, implying that animals may experience benefits similar to those of humans. This study tested the hypothesis that auditory enrichment changed the behavior of ten zoo-housed psittacines. All animals were exposed to six conditions of auditory stimulation; a 'control' (no auditory stimulation), and 'experimental' conditions, during which animals were presented with commercially-available CDs of classical music, pop music, natural rainforest sounds, parrot sounds and a talking radio. Each type of stimulation lasted

two days, with a wash-out day between different stimulation conditions. We recorded key parameters relating to the birds' social environment - whether they were group or single-housed and whether they had been hand or parent-reared. The parrots' behaviour was recorded every minute for a 25 minute period seven times a day using instantaneous sampling. The incidence of calm vocalisations and the level of preening changed with the different conditions. Birds exposed to rainforest and talking radio preened more than control birds. Birds exposed to several conditions of auditory stimulation expressed fewer calm vocalisations than control birds. A further finding from this study was that hand-reared birds exhibited dramatically increased incidences of stereotypic behavior, more learned vocalisation and interacted less with enrichment than parent-reared and the implications of hand rearing for welfare are discussed. Similarly solo housed birds showed changes in behavior compared to group housed, such as less preening and more stereotypic behaviour. Hand reared, solo housed parrots express less normal behavior and maybe at risk of impaired welfare.

Keywords: parrot, psittacine, welfare, hand rearing, auditory enrichment

1.1 Introduction

Millions of animals are kept in captivity globally, in zoos, laboratories, safari parks and animal shelters with millions more kept as pets (Wells, 2009). Parrots are the third most popular companion animal in the USA with estimated figures of 10 million individuals being kept as pets (Van Hoek and Cate, 1998 and Kalmar et al., 2010). Unlike many companion animals, parrots are only in the very early stages of domestication and are genetically similar to their wild ancestors, so their ethological needs in captivity

are complex and relatively unchanged from those in the wild (Meehan et al., 2003). Recently there has been an increased interest in the study of parrot intelligence, behaviour, and welfare (Engebretson, 2006; Pepperberg, 2006; Speer, 2014). In the wild animals are exposed to an ever-changing physical, social and sensory environment and one of the greatest challenges of keeping animals in captive conditions is providing enrichment that allows captive animals to engage in behaviour that satisfies their ethological requirements (Shepherdson, 2007). As a result of lack of appropriate behavioural opportunities or choices abnormal behaviours including stereotypies can occur (Mason, 1990), which are believed to be indicative of poor welfare. Stereotypic behaviour can be defined as a repetitive, unvarying and apparently functionless behaviour pattern which is rarely, if at all seen in the wild (Mason, 1991; Cooper and Nicol, 1996; Mason et al., 2007). Psittacines are particularly vulnerable to stereotypy (Van Hoek and Cate, 1998) which can include feather plucking, screaming, self-mutilation and, when all coping mechanisms fail, learned helplessness (Wilson, 2001; Garner et al., 2003; Mason et al., 2007; Van Zeeland et al., 2009). Concerns about abnormal and stereotypic behaviour displayed in captive animals have resulted in the development of environmental enrichment to allow animals to express more natural behaviour (Swaisgood and Shepherdson, 2005). Environmental enrichment is a common term used for improving the captive environment of animals and can be broadly defined as any technique used to improve the biological functioning and welfare of a captive animal through modifications of its environment (Newberry, 1995). It is thought that enrichment is a useful way to eliminate abnormal behaviours and improve animal welfare, if used in combination with other improvements in housing and husbandry (Mason et al., 2006).

To date, there are only a limited number of studies that have explored the effect of environmental enrichment on the behaviour and welfare of captive psittacines. Studies have focused on enclosure design and size (Mettke-Hofmann et al, 2002; Meehan et al., 2004) and enrichment through social and physical modifications (Meehan et al, 2003; Van Hoek and Cape, 1998; Kalmar, 2010; Kim et al., 2009). Findings from these studies showed that parrots without access to enrichment developed significantly more stereotypy than those that lived in enriched environments (Meehan et al., 2004).

The value of auditory stimulation for psychological well-being has been documented in humans (Maratos et al., 2008; Gold et al., 2009). It has been suggested that the moods (McCraty et al., 1998) and behaviour (Yalch and Spangenberg, 2000) of humans can be strongly influenced by the type of auditory stimulation to which they were exposed (Wells, 2009). For example, rock music can result in increased sadness, tension and fatigue, whilst "designer music" (music which is created to have a specific effect on the listener) results in relaxation (Wells, 2009). These results have led to research on the use of auditory stimulation for animal enrichment. Not only can auditory stimulation provide enrichment benefits but can also serve as a tool to mask potentially aversive noise and negative acoustic stimuli such as the sound of machinery (Wells, 2009).The value of music for improving welfare has been reported in animals (Kaplan 2009) including non-human primates (Shepherdson et al., 1989), African leopard *(Panthera pardus pardus)* (Markowitz et al., 1995; Troombridge et al., 1993), chickens *(Gallus gallus domesticus)* (Gvaryahu et al., 1989) and kenneled dogs *(Canis lupus familaris)* (Boone and Quelch, 2003). Many of these studies reported positive changes in the behaviour or physiology of the animals exposed to auditory stimulation which included ecologically-relevant sounds, classical music and radio broadcasts. Examples of the effects of enrichment included reduced respiratory rate in dogs (Wells et

al., 2002), improved growth rate of chickens (Gvaryahu et al., 1989) and reduced incidences of abnormal behaviour including stereotypy and enhanced general well-being in Asian elephants (Wells and Irwin, 2008) and African Leopards (Markowitz et al., 1995). Although birds have been shown to appreciate and respond to music (Kaplan 2009) to our knowledge, there have been no studies to date on the effectiveness of auditory enrichment for psittacines. This study aimed to determine whether different types of auditory stimulation had an effect on psittacine behavior.

Rearing method is known to have an effect on the behaviour and welfare of psittacines (Luescher & Sheehan 2005) as hand rearing involves separating the psittacine chick from its parents, thereby depriving the bird of contact which allows normal social and sexual development (Fox 2006). Hand reared birds are often imprinted socially and sexually onto humans, leading them to prefer contact with humans over that of conspecifics (Fox 2006). Thus, hand rearing has the potential to compromise welfare and has been banned in some EU countries, such as the Netherlands. Hand rearing is becoming increasingly popular to satisfy demand for tame birds from the pet trade (Schmid et al, 2006) so we also considered the effects of hand rearing vs parent rearing on the behaviour of the birds. As wild psittacines are highly social, isolation may be a welfare risk so we also looked at the effect of paired and single housing on several categories of behavior.

2.1 Methods

2.1.1 Subjects

A total of ten individuals were observed during this study, 1:0 yellow-headed amazon parrot *(Amazona Oratix)*, 1:1 african grey parrot *(Psittacus eithacus)*, 0:1 hyacinth macaw *(Anodorhynchus hyacinthus)*, 2:0 scarlet macaw (*Ara macao*), 0:2 military macaw (*Ara militaris)*, 1:1 blue and gold macaw *(Ara ararauna)*. Although the parrots were of several species, most parrot species have broadly similar behaviour and ethological needs (Meehan & Mench, 2006; Siebert 2006). Birds were aged between 3-24 years and were a mixture of hand and parent raised. Two of the parrots had been acquired from donations from the pet trade, therefore the exact age was unknown. All of the parrots were housed at the Zoological Society of London Whipsnade Zoo in UK and are housed in an indoor aviary overnight or during bad weather and outdoor aviary during the day, both of which are not on show to visitors. During observation times the birds were confined to the outdoor aviary as part of their normal daily routine with wire mesh separating birds from neighboring birds and from keepers. Food was unavailable during observations. Throughout the day the birds were trained and flown several times a day using positive-reinforcement techniques for the use of public demonstrations in an outdoor arena and were fed post-flight. During observations, each aviary included multiple natural perching branches, fresh browse and an enrichment item per aviary. The setup of aviaries was as follows: yellow-headed amazon parrot solo, African grey parrots together, hyacinth macaw solo, scarlet macaws together, military macaw together and blue and gold macaws solo.

The setup of the aviaries reflected the decisions made by the keepers at ZSL Whipsnade Zoo and housing conditions were not changed during the study. Some of the birds were solo housed because they were new and would later be introduced to the group, others were housed singly due to

inadequate socialization with other psittacines, such as aggressive behaviour and one bird was housed singly due to a previous medical condition.

2.1.2 Ethical Approval

Ethical approval for this study was obtained from the departmental ethics committee of Anglia Ruskin University where the authors formerly worked.

2.1.3 Behaviour

In order to determine which behaviour to observe, an ethogram was created (Table 1) by observing the birds' behavior in a pilot observation for several hours and by reference to papers describing the behavior of captive and wild psittacines (Engebretson, 2006; Leuscher, 2006; Meehan et al., 2003)

Table 1: An ethogram describing species-typical behaviour of psittacines.

Behaviour	***Description of behaviour***
Learnt Vocalization	Individual expresses a non-species typical sound which has been learnt, for example speaking in human language or copying a telephone ringing.
Calm vocalization	Individual expresses a species-typical sound associated with being calm. In general the calm vocalisations included contact calls, chucking, purring etc.

	and were low in volume, pitch and intensity and were often accompanied by other calm behaviors, maintenance behaviors or non-agonistic social encounters
Nervous vocalization	Individual expresses sounds which are typically associated with being nervous such as alarm calling and loud or repetitive screaming. This is high in pitch and volume and may be accompanied by other behavior indicating alarm such as increased vigilance or rapid flight, wing flapping, or agonistic encounters
Preening	A form of grooming behaviour performed by birds as part of feather maintenance, it consists of cleaning and arranging the feathers (McFarland, 2006). Individual uses the beak to clean the feathers, and the wings flap to rearrange and get rid of dirt particles. Individuals only preen when they are in a relatively calm, safe environment.
Rouse	This involves and individual ruffling the feathers, resulting in a release of tension.
Vigilance	Bird is alert, watchful and scans the environment
Stereotypic behavior	Defined as a repetitive apparently functionless behavior. There were four types of stereotypic behavior observed in the study: feather plucking - a maladaptive behaviour which involves individuals using the beak to chew or pull out feathers, most commonly seen on the chest. Locomotor stereotypies involve the repetition of an identical pattern of foot and body movement. Oral stereotypy involves the repetition of identical patterns of oral movements such as spit chewing or food manipulation. Bar biting involved a

	parrot gnawing repeatedly on the wire of the aviary. While gnawing the parrot may pull violently. As bar biting was of particular interest to Whipsnade Zoo (being the most prevalent stereotypy) we observed this separately.
Hang	Parrot hangs by one foot from the roof of the enclosure
Foraging	Interaction with foraging browse provided
Bar biting	See above under "Stereotypic behavior"
Locomotion	Individuals move around their environment, either walking on a surface or using their beak to climb.
Interacting with Enrichment	Individual interacts with the enrichment item provided
Resting	Individuals typically seen with the head positioned into the side of the wings.
Allogrooming	Two individuals preen each other using the beaks. This is a positive social encounter indicative of an affiliation or pair bond
Social Interaction	An individual interacts with another individual for example sitting next to each other within wingspan-distance, not including allogrooming.
Social Aggression	An individual interacts with another individual agonistically for example attempting to bite others or exhibiting loud agonistic vocalization directly at an individual.
Drinking	Individual consumes water
Flight	Individual moves around the enclosure using flight

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135 2.1.4 *Auditory Enrichment*

136 Auditory enrichment was played using an iPod© docking station at a volume of 48 dB and was located
137 3 metres away from the nearest parrot enclosure (Figure 1). This amplitude was chosen after
138 consultation with zookeepers, as being a comfortable level, slightly louder than normal conversational
139 speech. Six conditions of auditory enrichment were used for the study, this included a control (no
140 music), classical music, pop music, natural rainforest sounds, parrot vocalisations and a talking radio.
141 In the control condition, parrots were exposed to no auditory stimulation other than naturally arising
142 sounds in the animal's environment such as sounds created during keeper husbandry duties and noises
143 made by other animals within the zoo. During the "no music" condition the auditory system was
144 turned off and unplugged to ensure no background sounds were emitted. During the natural rainforest
145 condition the animals were exposed to a selection of tracks from the "Rainforest Sounds" album (Best
146 of Mother Nature, 2010), which contained forest sounds such as rains and rivers from tropical forests.
147 During the classical condition, the parrots were exposed to a randomly chosen mixture of tracks from
148 the "Now that's What I Call Classical" album (Various Artists, 2013). During the pop condition, the
149 parrots were exposed to a randomly chosen mixture tracks from the "Pop Party 12" album (Various
150 Artists, 2013). During the parrot vocalization condition, the animals were exposed to a selection of
151 tracks from the "Voices of The New World Parrots" album (Whitney et al., 2002), which contained
152 vocalisations of parrots including various macaw species, during flight and when perched. During the

153 talking radio condition, the parrots were exposed to LBC Radio (LBC, 2014). During all types of
154 auditory stimulation conditions the animals were exposed to naturally arising auditory stimulation
155 from their environment.

156 *2.1.5 Procedure*

157 Prior to the study, species were informally observed to record species-typical behaviours and an
158 ethogram was created. The parrots were first studied in the control condition, followed by the
159 experimental condition, followed by a wash out day and repeated until all experimental conditions had
160 been observed. Each experimental condition was studied for two consecutive days and was separated
161 by a wash-out period for 24hours where the animals were exposed to no auditory stimulation except
162 naturally occurring sounds within their environment. All birds were always presented with the same
163 auditory stimulation at the same time of the day during experimental conditions. Testing was
164 conducted between 08:30 - 14:00h in July and August 2014.

165 The behaviour of each parrot was recorded by one experimenter for all the conditions. The observer
166 watched silently for a 25 minute observation period from a distance of between 5 and 20 metres
167 depending on the bird being observed, and no instruments were used to enhance the viewing.
168 Instantaneous sampling techniques were used, recording each parrot's behaviour once every five
169 minutes. During each observation period all 10 individuals were recorded, each individual parrot was
170 on a different ten second instant to allow movement time to optimize viewing. Each parrot was
171 exposed to each condition twice, resulting in 20 data points for each condition. In total, 175 minutes of
172 observations were made each day at the following times: 08:30,09:00,09:30,10:00,10:30,12:00,12:30. To

minimize observer effects on behaviour, a minimum distance of 5 metres was kept between bird and observer at all times. The parrots were also categorized as solo or group-housed, and parent or hand-reared.

2.1.6 Data Analysis

The category "social aggression" was removed from the analysis because of a low frequency recorded. Social aggression was only recorded twice in the study probably because the birds were housed in stable pairs or singly. Before testing for allogrooming and social interactions, data on solo-housed individuals were removed from the set. Statistical analysis of comparison between auditory stimulation conditions was conducted using Small Stata 11 accepting a significance level of < 0.05 or <0.01 when corrected for multiple testing (post hoc T-tests). The total number of times each animal was observed performing each behaviour was calculated for each different condition of auditory stimulation, providing overall frequency counts per parrot per behaviour. Data were tested for normality. For normally distributed data, repeated measures one-way ANOVA with Box's conservative epsilon correction was used to determine whether the animals' behaviour was influenced by their auditory environment. For non-normally distributed data Friedman's ANOVA was used. Post-hoc t-tests were used to determine which enrichment categories were different from control with a significance level of $p<0.01$ after Bonferoni correction. To test for differences in behaviour caused by paired or solo housing, and hand or parent rearing Mann-Whitney Rank Sum tests were carried out.

3.1 Results

193 *3.1.1 Auditory enrichment*

194 For the various categories of behaviour studied, only preening behavior and calm vocalisation showed
195 significant differences between groups (Table 2).

196 Table Two: Results of Within-Subject Friedman's ANOVA (or *repeated measures ANOVA) across
197 six conditions (control, classical music, pop music, parrot sounds, rainforest sounds and a talking
198 radio) for a series of behavioural measures.

Behaviour	F	p
Interaction Enrichment	28.0286	0.0829
Vigilance	2.48*	0.130
Locomotion	27.8238	0.0869
Resting	24.0619	0.1938
Preening	**5.73***	**0.026**
Calm vocalisation	**4.41**	**0.048**
Stereotypy	12.0762	0.8823
Hanging	13.8024	0.7951
Drinking	13.0643	0.8353
Nervous vocalisation	7.7381	0.9891
Bar biting stereotypy	15.081	0.7174
Foraging	7.5762	0.9905
Rouse	5.1357	0.9993
Learned vocalisation	7.0238	0.9941

Flight	7.3548	0.9921
Allopreening	11.1667	0.4294
Social interaction	11.0769	0.4368
* Repeated measures ANOVA [F]		
Significant outcomes in bold		

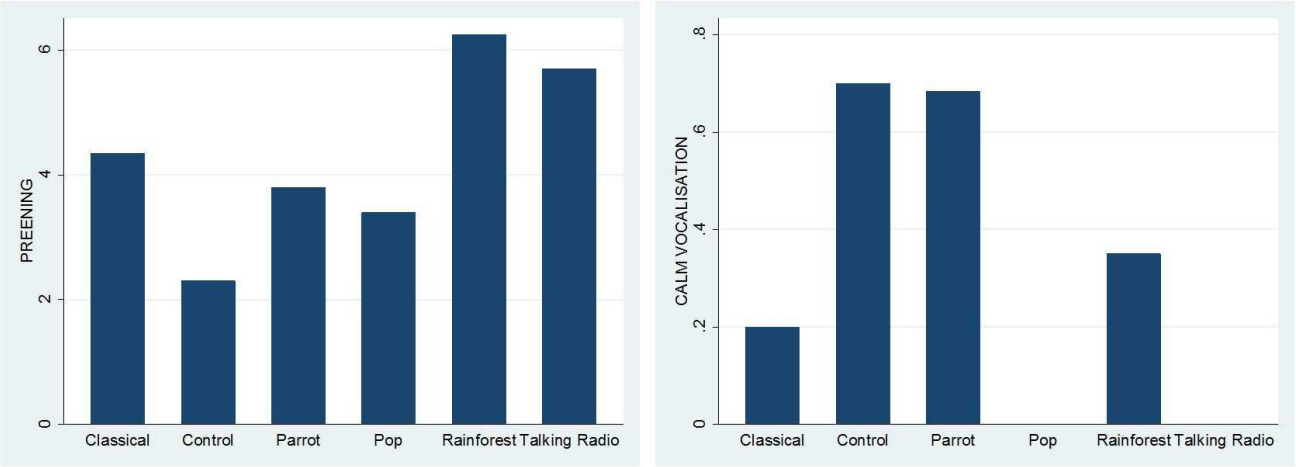


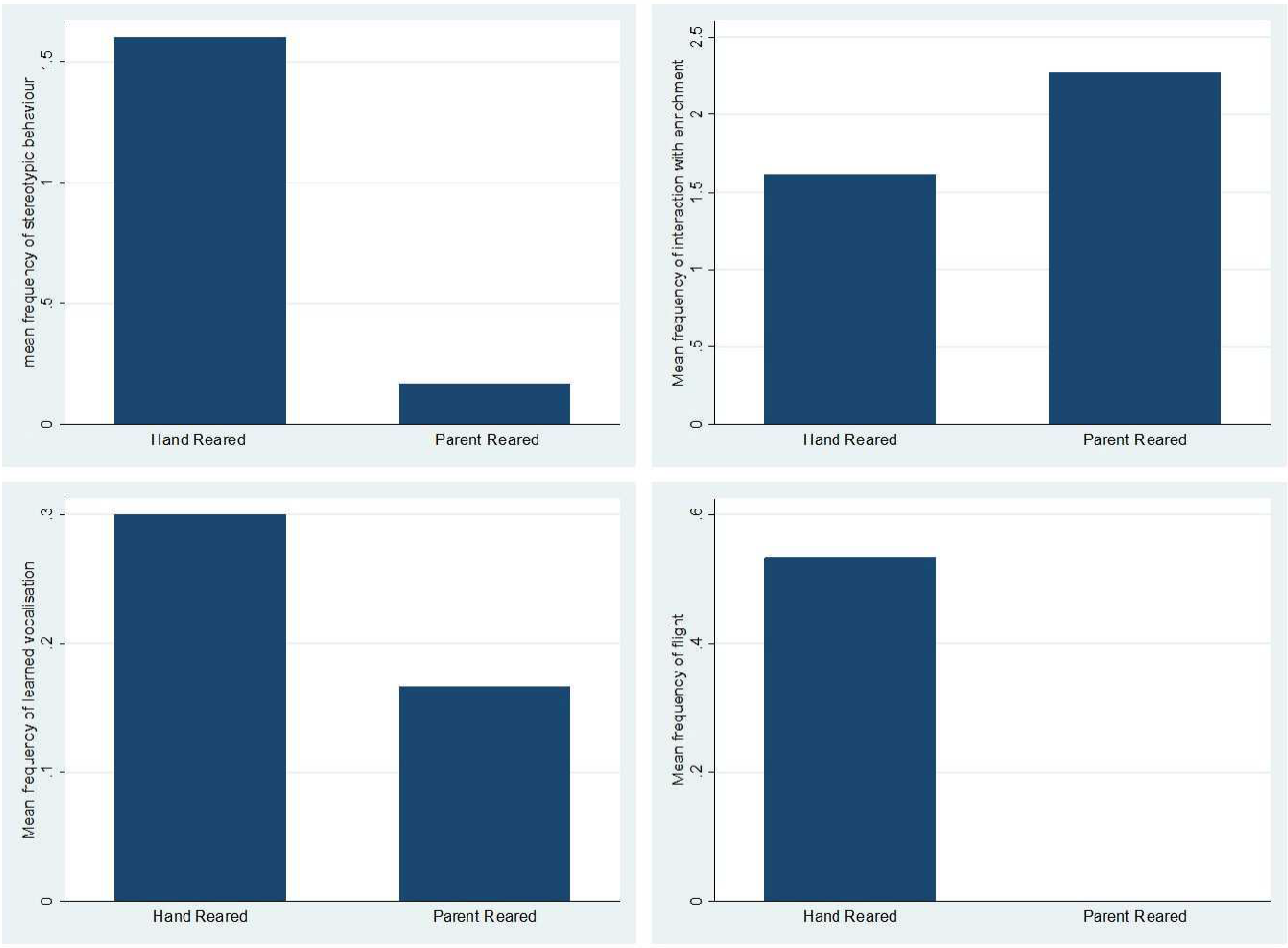
Figure 2. Frequency of preening (left) and calm vocalization (right) in the various auditory enrichment categories.

For calm vocalization (Figure 2) the following conditions were significantly different from control (using a significance level of 0.01 after correction for multiple testing): pop v control (paired t-test; n=10; p=0.0034) and talking radio v control (paired t-test; n=10; p=0.0034). Talking radio and pop music reduced the level of calm vocalization to zero in all birds.

208 *2.1.2 Rearing method*

209 Hand reared individuals interacted less frequently with enrichment and showed more stereotypic

210 behavior, learned vocalization and flight (Table 3; Figure 3).



211

212 **Figure 3.** Mean frequencies of stereotypic behavior, interaction with enrichment, learned vocalization

213 and flight in hand-reared and parent-reared birds.

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Table 3: Outcomes of Mann-Whitney U tests, testing behavioural differences when categorized into hand or parent reared. Significant outcomes in bold.

Behaviour	z	p
Enrichment	**-2.022**	**0.0432**
Vigilance	-0.357	0.7207
Locomotion	1.024	0.3058
Resting	-0.852	0.3944
Preening	-0.619	0.5358
Calm vocalisation	1.467	0.1424
Stereotypic behaviour	**2.627**	**0.0086**
Hanging	-0.827	0.4083
Drinking	0.616	0.5376
Nervous vocalisation	0.51	0.6102
Bar-biting	0.154	0.8778
Foraging	-0.581	0.5612
Rouse	-0.937	0.3488
Learned vocalisation	**2.107**	**0.0351**
Flight	**3.155**	**0.0016**

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222 *2.1.3 Housing method*

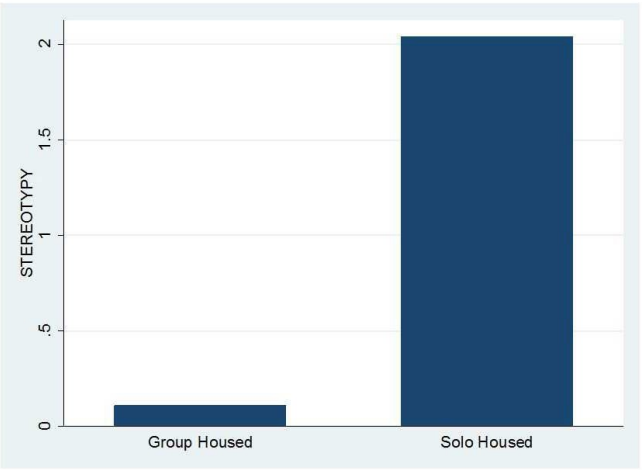
223 Solo housed individuals showed a large increase in stereotypic behavior (a total of 118 incidences
224 compared to just 8 in the group-housed birds) and less preening than group housed individuals (Table
225 4; Figure 4).

226 Table 4. Results of Mann-Whitney U, testing the behavioural differences between solo or group
227 housed birds. Significant outcomes in bold.

228

Behaviour	z	p
Enrichment	-0.093	0.9257
Vigilance	-0.038	0.97
Locomotion	-1.412	0.158
Resting	0.03	0.9761
Preening	**3.448**	**0.0006**
Calm vocalisation	-0.816	0.4144
Stereotypic behaviour	**-2.396**	**0.0166**
Hanging	0.695	0.4872
Drinking	0.259	0.7953
Nervous vocalisation	-1.016	0.3098

Bar-biting	1.482	0.1383
Foraging	-0.382	0.7023
Rouse	-0.939	0.3479
Learned vocalisation	-0.457	0.6477
Flight	0.499	0.6181



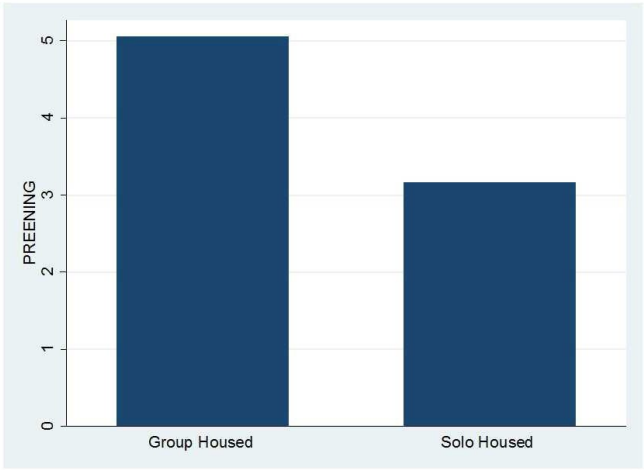


Figure 4. Mean frequencies of stereotypic behavior (left) and preening (right) in group-housed or solo-housed birds

4.1 Discussion

Psittacines in captivity are highly prone to stereotypic patterns of behaviour, often thought to be caused by factors including lack of social interactions with other psittacines and housing conditions (Garner et al., 2006). The most common stereotypic behaviour displayed in parrots includes feather plucking (Van Zeeland et al., 2009), followed by biting and screaming (Wilson, 2001), although at Whipsnade Zoo bar biting was the most prevalent. Some handlers and owners consider stereotypic behavior to be relatively normal or a coping strategy, or even facilitating circulation or aiding digestion in the absence of flying (Koolhaas et al., 1999 and Van Zeeland et al., 2009). Others believe that repetitive patterns of behaviour may be signs of stress brought out by factors such as social isolation (Garner et al., 2006). The function of stereotypic behaviour in parrots, as well as other species is complex and needs careful investigation. Whatever the underlying cause and possible function, stereotypies are generally regarded as an indicator of reduced welfare and enrichment is a potential way reduce stereotypy and promote normal behaviour.

4.1.1 Auditory Enrichment

The value of music for psychological well-being is well documented in humans (Maratos et al., 2008 and Gold et al., 2009), suggesting that moods (McCraty et al., 1998) and behaviour (Yalch and Spangenberg, 2000) can be strongly influenced by the auditory environment. Research has suggested

that classical music benefits humans, resulting in increased relaxation (Wells, 2009) and in animals has been shown to reduce stereotypy, demonstrated in Asian elephants (*Elephas maximus*) (Wells and Irwin, 2008), and decrease aggression (Western Lowland gorillas (*gorilla gorilla*)) (Wells et al., 2006). Studies have also found significant effects of auditory enrichment on zoo species including African leopard (*Panthera pardus pardus*) which showed greater levels of activity when exposed to natural habitat sounds, and radio broadcasts have been found to lower the heartrate of baboons (Brent and Weaver, 1996). Auditory enrichment may be a potentially effective, low-cost and easy form of enrichment. With lack of time commonly being cited as the single biggest obstacle that keepers face in increasing enrichment (Swaisgood and Shepherdson, 2005) the use of auditory stimuli may present an important mechanism for providing effective enrichment and enhancing the welfare of animals without being time consuming. This study found that most behaviours in the zoo-housed psittacines were not affected by auditory enrichment, but the behavior categories calm vocalization and preening did show some changes.

4.1.2 Calm vocalization

Calm vocalization in psittacines comprises contact calls (which birds use to keep contact within the "flock" which can involve birds in nearby aviaries as well as human caretakers). Calm vocalisations also comprise a series of chuckles which indicate calm behavior and these sounds are made as the birds go about their business of foraging, grooming etc. Thus, calm vocalizations are part of the normal behavioural repertoire of psittacines and may indicative of adequate welfare, when taken with other

observations such as relaxed body language and preening. Pop music and talking radio reduced the level of calm vocalisations to zero, indicating that these sounds may not be beneficial to parrots. Possibly talking radio and pop music mask the normal vocalization of the birds. As the default background music for many zoos (including Whipsnade) is talking radio interspersed with pop, zoos may want to consider the auditory environment and how it may be affecting psittacines.

4.1.3 Preening

For preening (Figure 2), auditory enrichment appeared to increase the amount of preening shown. Preening is a maintenance behavior and a part of psittacine's normal repertoire of behavior (Van Zeeland et al., 2009). However over-preening is linked to stereotypy and feather-plucking (Van Zeeland et al., 2009; Rubinstein and Lightfoot., 2012). Therefore these results are difficult to interpret, and further research is needed. It is possible that there was an interactive effect between auditory stimulation and the presence of a staring observer which may have led to a stress related increase in preening. Preening behaviour in psittacines seems particularly labile and may be an important welfare indicator; this warrants further investigation.

Further work is needed to understand and unravel the specific acoustic elements that animals respond to and determine whether they serve as a mask for aversive sounds, mask species specific vocalisations, or exert an enriching neurophysiological effect. Therefore, further research is needed to determine the long-term effects of auditory stimulation on a larger number of captive psittacines before generalized

conclusions can be drawn. Measurements could be made in combination with physiological welfare indicators such as cortisol levels.

4.1.4 Rearing method

Hand reared individuals interacted less frequently with enrichment and showed more stereotypic behavior, learned vocalization and flight (Table 3; Figure 3). These results support the view, shared by many psittacine behavior experts, that hand-rearing of psittacines leads to abnormal sexual and social behavior later in life and may result in impaired welfare. As hand-rearing has been banned in some countries such as the Netherlands, it is clear that some governments support this view. Parrots often being hand raised to satisfy demand from the pet trade for tame birds (Schmid et al., 2005) so it is important to understand the behavioural and welfare consequences. Schmid et al (2005) found that African grey parrot (*Psittacus erithacus*) chicks that had been removed from parents at less than five weeks of age developed more stereotypies than chicks which stayed longer with their parents and our results support this study. More research is needed, particularly in psittacines kept as companion animals, into the effects of hand rearing on behavior and welfare.

4.1.5 Paired or Single housing

Solo housed individuals showed a large increase in stereotypic behavior (a total of 118 incidences compared to just 8 in the group-housed birds) and less preening than group housed individuals (Table

4; Figure 4). Preening is a maintenance behavior and part of the psittacine's normal behavioural repertoire, but the preening result is difficult to interpret. Very little preening would be considered abnormal, as would over-preening. More research is needed on what constitutes normal levels of preening in psittacines. Stereotypic behavior increased fourteen-fold in the single housed birds, and this supports results of Meehan et al. (2003) that paired housing improves welfare and reduces stereotypy in captive psittacines compared to being housed singly. Psittacines are highly social and generally live in large communal groups. Their predators are numerous and flocking behaviour protects individuals from predation, hence the presence of conspecifics is a survival issue (Stamps et al. 1990). In the wild, parrots are never alone and isolation from conspecifics may be highly psychologically distressing for captive psittacines. Having said that, at least some of the single housed birds had preexisting medical or behavioural problems which led to the decision of ZSL Whipsnade Zoo to isolate them. Therefore the result on single housing must be interpreted with caution; our study does not claim to have disentangled effects on solo housing from preexisting behavioural issues. Nevertheless, previous research (Meehan et al. 2003; Garner et al. 2006) and knowledge of the behavioural ecology of psittacines suggest that single housing is not desirable and zoos and private individuals should only house psittacines alone when there is no other option

It is important to take into consideration that this study was relatively short in duration, with a small sample size. Although each of the conditions (control-experimental-control) designed for this study were relatively short in duration (two days each) results still indicated a change in behaviour.

The observer wearing staff uniform may have affected the results due the association with food, and training. These birds are also trained to be used in daily animal demonstrations therefore have a different husbandry regime than other zoo housed parrots therefore they receive significantly more human interaction for training sessions and are very fit birds due to receiving regular exercise through free flight three times a day.

We would like to point out a further limitation of the study; amplitude and sound quality were not controlled for. As birds have been shown to be particularly sensitive to musical sounds (Watanabe & Sato 1999; Watanabe et al. 2005), it is important to realize that they may not hear sound in the same way that humans do. We would not want our study to provide an endorsement for low quality musical enrichment applied indiscriminately and at inappropriate volumes, as this may reduce, not increase welfare. Instead we hope our study will be used to further investigate and refine the potential use of auditory enrichment in zoo-housed psittacines and other captive birds.

5.1 Conclusion

Overall, this study suggests that captive parrots' behaviour can be influenced by their auditory environment, as well as their social grouping and their rearing history. However, this study was conducted on a small number of animals over a short period of time. Therefore, further research is necessary to determine the long-term effects of auditory stimulation using a larger sample size before generalized conclusions can be confirmed. The results also show that single housing and hand rearing may be risk factors for reduced welfare. Singly housed hand reared birds (which is the usual condition in the companion animal situation) may be particularly at risk. Preening appears to be a labile behavior

362 and investigation into what is normal and how this is affected in poor welfare states may prove
363 interesting. The authors intend to continue research on the effects of hand rearing on captive
364 psittacines, as well as extending the current study on auditory effects.

365

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